

ANSI C78.387b-1998
Supplement to ANSI C78.387-1995

American National Standard

Approved April 28, 1998

Secretariat: National Electrical Manufacturers Association

for electric lamps—

Metal-Halide Lamps— Method of Measurement for Containment Testing

INSTRUCTIONS:

Place the attached pages into ANSI C78.387-1995 to replace page 17/18 of the existing standard.

Discard this instruction sheet when finished.

NOTE: It was our practice in 1997 to formalize supplements in such a way as to publish only the affected pages to ease of updating the original standard by merely replacing the necessary pages. As of 1998, this feature will be enhanced by the shading of the relevant text of which this paragraph is an example.



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First Edition
July 1998

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Supplement to ANSI C78.387-1995**

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9.2.1.4 The linear reactor, if not of the fixed type, shall be adjusted to the values specified in the appropriate ANSI C78.13XX standard and in accordance with the procedure outlined in ANSI C82.5, as referenced in Section 2.

9.2.2 Procedure

The test procedure shall be as follows:

- (1) Open starting switch, insert lamp, and reclose starting switch.
- (2) Increase the input voltage until the lamp strikes; return to specified rated input voltage.
- (3) Record the reignition-spark voltage, this should normally reach a maximum within 15 to 45 seconds after the lamp strikes.
- (4) The lamp shall be aged within $\pm 10\%$ of its rated wattage for a minimum of 5 minutes after a measurement.
- (5) The lamp should be allowed to cool at room temperature in still air between measurements.

10 Containment testing procedure

10.1 General

10.1.1 Scope

This method of measurement applies to metal halide lamps with quartz arc tubes that are intended to retain all particles within the outer bulb should an arc-tube rupture occur.

10.1.2 Purpose

Certain metal halide lamps are susceptible to non-passive failure at end of life. To insure the safety of the environment in which the lamps operate, it is recommended that these metal halide lamps be operated in closed luminaires that meet the lamp containment barrier requirements of UL 1572, section 57A. However, certain other metal halide lamps are not susceptible to non-passive failure at end of life, or they are capable of containing all particles within the outer bulb in the event of an arc-tube rupture. The purpose of this test is to determine which metal halide lamp constructions are containment-safe.

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10.1.3 Test description

The test consists of discharging a capacitor through an operating lamp to simulate an end-of-life arc-tube rupture. In the first part of the test, the minimum energy required to insure rupture of the arc tube is determined. In the second part of the test, arc tubes are forced to rupture at the minimum energy, and the lamps are examined for damage to the outer bulb.

A large amount of research has been carried out to make this test as realistic as possible. However, the test differs from real end-of-life situations in a number of ways, including: a) the lamps are new, b) a high energy input into the arc tubes is required to make them rupture, leading to higher pressures and greater powers than typical end-of-life ruptures, and c) the arc-tube rupture mechanism may not be the same as that for end-of-life lamps.

10.2 Experimental setup

10.2.1 Safety precautions

High voltages and high electrical energy levels are involved in this test, so extreme caution is required. Fragments of hot lamp parts can be generated if the outer bulb is damaged, so a physical enclosure is required. Precautions should be taken to contain and clean up mercury and other hazardous materials from the lamp in the event of penetration of the outer bulb.

10.2.2 Electrical circuit

The basic electrical circuit used for containment testing of metal halide lamps is shown in Figure 10.1. The main components include: 1) a power supply for operating the lamp, 2) a ballast for limiting current to the lamp, 3) a dc power supply for charging the discharge capacitor, 4) a discharge capacitor for storing energy for the containment test, 5) a charging resistor for charging the discharge capacitor, 6) a discharge resistor for discharging the capacitor after the test, 7) a VAW meter for measuring the lamp electrical operating characteristics and 8) a V_c meter for measuring the capacitor voltage. Specific details for designing and operating such a circuit can be found in GE publication *Design of a metal halide capacitive discharge tester*.

An alternative circuit using a dc power supply and a ballast resistor for operating the lamp has also been used for this test and is under consideration.

Since circuit impedance can affect the test results, the lead wires between the discharge capacitor and the lamp shall be less than one meter long and have a wire gauge diameter of AWG 4 or larger.

The capacitor discharge dc power supply shall be capable of charging the discharge capacitor to any voltage between 500 and 2500 V. The value of the charging resistor can be adjusted so that the power supply can charge the capacitor within a reasonable amount of time.

The discharge capacitor shall have a value of 10 - 50 μ F and shall be capable of handling 2500 V.

The lamp power supply shall be capable of supplying the lamp with sufficient voltage and current to operate the lamp at its nominal operating wattage. A timing circuit may be inserted into the circuit so that the capacitor is discharged at the point in the electrical phase when the current is at its maximum.

The ballast may comprise a suitable hi-pot inductor. The ballast shall have an impedance as specified in the ANSI reactor ballast setup for the lamp under test. It shall be capable of withstanding short-term high voltage pulses of 2500 V.

The switches shall be capable of withstanding short-term high voltage pulses of 2500 V in their open condition.

The discharge resistor shall have a rating of 1000 ohm - 25 W.

10.2.3 Enclosure requirements

The enclosure for containment testing of metal halide lamps shall be constructed of materials capable of withstanding the impact of hot particles (particles of up to 1.1 g at 100 °C travelling at 50 m/s). Suitable materials include sheet metal and polymers that meet the lamp containment barrier requirements of UL 1572 section 57A. Metal enclosures shall be electrically grounded.

The enclosure shall be equipped with a suitable lamp socket for operating the lamp under test in the base-up position, or in the specified position of the lamp.

The dimensions of the enclosure are not critical, but they should be large enough to accept the lamp under test and give a clearance of approximately 12" (30.5 mm) at the sides and below the lamp.

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10.3 Procedures and definitions

10.3.1 Lamp selection and preparation

Lamps for this test shall be selected randomly from normal production or from pilot runs. The lamp construction dimensions shall fall within the manufacturer's specified values.

10.3.2 Determination of minimum energy setting

In order to determine the minimum energy setting which insures rupture of the arc tube within the lamp, the following procedure shall be carried out, with reference to Figure 10-1. Note that these steps need to be carried out for each different lamp type.

1. Select an initial energy value of 5 J by selecting the capacitor dc power supply voltage according to $V = (2E/C)^{1/2}$, where V is the capacitor voltage in volts (V), E is the energy in joules (J) and C is the capacitor value in farads (F).
2. Open switches S1, S2, S3, S4; close switches S5 and S6.
3. Insert a lamp into the test socket.
4. Turn on the lamp power supply and adjust to approximately the correct parameters to operate the lamp. Use of this power supply may or may not require additional means of starting.
5. Start the lamp by means of a tesla coil, and close the enclosure securely. Some lamp types may not require an additional starting aid.
6. After 5 minutes, close switches S1 and S2, and open switch S6.
7. Determine the lamp electrical operating point by means of the VAW meter and adjust the power supply as necessary to bring the lamp to its nominal operating point.
8. Allow the lamp to operate for 20 minutes.
9. While waiting for the lamp to warm up, turn on the capacitor dc power supply, open switch S5 and close switch S4 to begin charging the capacitor; monitor the capacitor voltage by means of the V meter.
10. After the capacitor has reached its final charge and the lamp has operated at least 20 minutes, close switch S6 and open switches S1, S2 and S4.
11. Close switch S3 to discharge the capacitor through the lamp.
12. After the discharge, open switch S3 and close switch S5; turn off both power supplies.
13. If the arc tube ruptured at step 11, then repeat steps 2 - 12 until 8 lamps have been tested. If at least 4 out of 8 arc tubes ruptured, then the energy and voltage values shall be recorded, and these values shall be used for the rest of the test as described in section 10.3.3.

14. If the arc tube did not rupture in step 11, or if less than 4 out of 8 arc tubes ruptured in the ensuing attempts, then the voltage value shall be increased to obtain an energy increase of 5 J, and steps 2-13 shall be repeated. If the arc tubes do not rupture reliably after increasing the voltage to 2500 V, an increase in capacitance may be required.

10.3.3 Containment test procedure

After the minimum energy required to insure rupture of the arc tube has been determined (see previous section), the following procedure shall be carried out to determine whether the lamps are containment-safe.

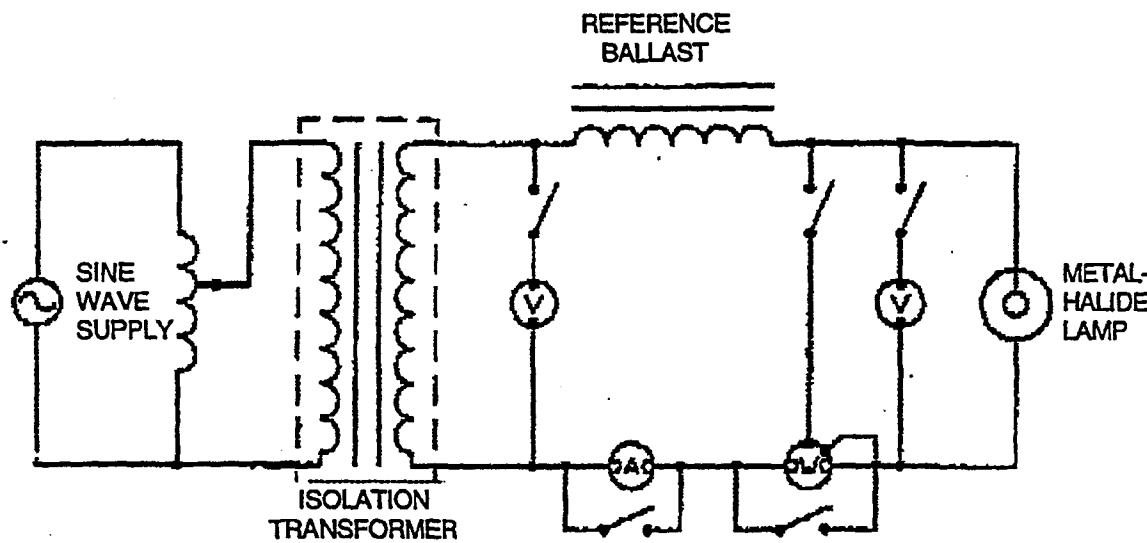
Follow steps 2-12 in the previous section (with the minimum energy value that insures rupture of the arc tube, as determined in that section). This procedure shall be followed until all the lamps of the test group have been evaluated. The lamp manufacturer shall determine the quantity of lamps to be included in this test group.

Each of the lamps with ruptured arc tubes shall be examined for damage to the outer bulb. For the purposes of this test, damage to the outer bulb constitutes any shattering, punctures, or holes in the bulb wall. Scratches, cracks, and chips on the bulb wall are allowed, as long as all fragments are contained within the bulb, and the bulb remains intact.

10.3.4 Definition of containment-safe

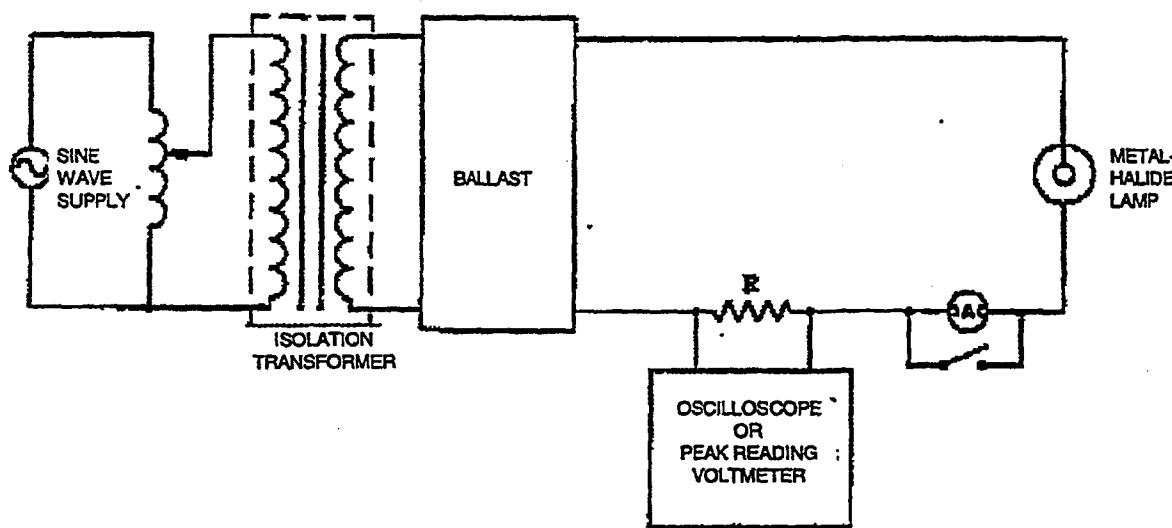
If none of the lamps from the previous section shows any damage to the outer bulb (as defined in 10.3.3), then the lamp construction is containment-safe. If one or more of these lamps shows damage to the outer bulb (as defined in 10.3.3), then the lamp construction is not containment-safe.

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Note: Current terminals are shown as \odot . Potential terminals are shown as \bullet .
Warning: Refer to 3.5.4 through 3.5.8 for circuit and equipment grounding

Figure 1
Reference Ballast Circuit for Metal-Halide Lamps



Note: Current terminals are shown as \odot . Potential terminals are shown as \bullet .
Warning: Refer to 3.5.4 through 3.5.8 for circuit and equipment grounding

Figure 2
Circuit for Measurement of Lamp Current Crest Factor

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PRODUCT
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AMERICAN NATIONAL STANDARD

**PRODUCT SAFETY
SIGNS AND LABELS**

Secretariat
National Electrical Manufacturers Association

Approved April 28, 1998
American National Standards Institute

American National Standard

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Published by

National Electrical Manufacturers Association
1300 N. 17th Street, Rosslyn, Virginia 22209

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Printed in the United States of America

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ANSI Z535.4-1998

Foreword (This foreword is not part of American National Standard Z535.4-1998.)

In 1979, the ANSI Z53 Committee on Safety Colors was combined with the ANSI Z35 Committee on Safety Signs to form the ANSI Z535 Committee on Safety Signs and Colors. This committee has the following scope:

To develop standards for the design, application, and use of signs, colors, and symbols intended to identify and warn against specific hazards and for other accident prevention purposes.

Five subcommittees were created and assigned the tasks of updating the ANSI Z53 and Z35 Standards, and writing two new standards. The five standards include:

- ANSI Z535.1, Safety Color Code [ANSI Z53.1-1979 was updated and combined into this standard in 1991.]
- ANSI Z535.2, Environmental and Facility Safety Signs [ANSI Z35.1-1972 and Z35.4-1972 were updated and combined into this standard in 1991.]
- ANSI Z535.3, Criteria for Safety Symbols [new in 1991]
- ANSI Z535.4, Product Safety Signs and Labels [new in 1991]
- ANSI Z535.5, Accident Prevention Tags (For Temporary Hazards) [ANSI Z35.2-1974 was updated and combined into this standard in 1991.]

This standard was prepared by Subcommittee Z535-4 on Product Safety Signs and Labels.

There are two annexes in this standard. Both Annex A and Annex B are considered to be informative and not considered part of this standard.

Together, these five standards contain information needed to specify formats, colors, and symbols for safety signs used in environmental and facility applications, product applications, and accident prevention tags.

This Standard provides guidelines for the design of safety signs and labels for application to products. These guidelines have been in use since 1991, when this Standard was first published. There are only minor modifications to these guidelines in this revision, mostly editorial changes to provide clarity. The major revision in this document is in the revision of Annex A and Annex B, which are not an official part of this Standard. Annex A promotes the explanation of the use of the safety label components in collateral material used with the product. Annex B provides principles and guidelines for the design of product safety signs. The subcommittee hopes that Annex A and Annex B are of value to the reader of this standard.

This standard was processed and approved for submittal to ANSI by the Accredited Standards Committee on Safety Signs and Colors, ANSI Z535. Committee approval of this standard does not necessarily imply that all committee members voted for its approval. At the time it approved this standard, the Z535 Committee had the following members:

Gary M. Bell, Chairman
Anthony L. Martino, Vice Chairman
Ronald R. Runkles, Secretary

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ANSI Z535.4-1998

American National Standard

for Product Safety Signs and Labels

1 Introduction

The design of safety signs¹ for products has been influenced for many years by standards originally developed for accident prevention signs to be used in the general environment. As product safety signs evolved, some basic differences developed between their characteristics and those of environmental safety signs: Environmental safety signs are usually larger, observed at longer distances, and frequently contain lesser amounts of information for visual clarity at a distance. Product safety signs are likely to contain more information within a smaller format, are usually observed at closer distances, and must physically and visually integrate with a wide range of product size, shape, and color characteristics. Attempts by product manufacturers to address these variable characteristics have produced numerous approaches to the graphic treatment of such signs.

This standard sets forth a hazard communication system developed specifically for product safety signs and labels. It consolidates a number of previous graphic approaches into a common design direction carefully selected to present product hazard information in an orderly and visually consistent manner for effective communication.

The ANSI Z535.4 standard developed for product safety signs and labels complements the ANSI Z535.2 standard developed for environmental and facility safety signs. These standards are similar in many respects, however, they each address different physical and visual requirements as noted above. In this regard, the Accredited Standards Committee Z535 has recognized and affirmed the need for these two standards.

2 Scope and purpose

2.1 Scope

This standard sets forth performance requirements for the design, application, use, and placement of safety signs and labels intended to identify

potential hazards for persons using, operating, servicing, or in proximity to, a wide variety of products. A product safety sign or label should alert persons to a specific hazard, the degree or level of hazard seriousness, the probable consequence of involvement with the hazard, and how the hazard can be avoided.

2.2 Purpose

The purposes of this standard are: (1) to establish a uniform and consistent visual layout for safety signs and labels applied to a wide variety of products, (2) to minimize the proliferation of design for product safety signs and labels and (3) to achieve application of a national uniform system for the recognition of potential personal injury hazards for those persons using products.

2.2.1 There are a number of existing American National Standards which are recognized for particular industries or specific uses. Compliance with such a standard may be considered for the particular industry or use. It is not the intent of this ANSI Z535.4 standard to replace existing standards or regulations which are uniquely applicable to a specific industry or use. It is the intent to encourage adoption of this standard in subsequent revisions of other standards and regulations.

3 Application and exceptions

3.1 Application

This standard provides guidance for manufacturers, employers, distributors, and others who have a desire to alert persons to potential personal injury hazards inherent with products. For chemical products and chemical mixtures follow ANSI Z129.1-1994.

3.2 Exceptions

3.2.1 Should any of the requirements of this standard conflict with federal, state, or municipal regulations, such conflict shall not invalidate other sections of this standard.

¹ In this standard, the term "sign" will be used to mean either a product safety sign or label.

3.2.2 Should it be necessary to use the same graphic system for product safety signs and for environmental and facility safety signs, the graphic system as defined in this standard (see section 6 and 7.1 through 7.5) or as defined in ANSI Z535.2-1998, *Environmental and Facility Safety Signs* (see sections 5.1.2, 5.2.2, 5.3.2) may be used.

4 Definitions

4.1 accident: An occurrence in a sequence of events that produces unintended injury, death or property damage.

4.2 colors: Colors specified in this standard shall conform to American National Standard *Safety Color Code*, ANSI Z535.1-1998.

4.3 decal: (See safety sign.)

4.4 hazard: A source of potential injury to a person.

4.5 Intent

4.5.1 may: This word is understood to be permissive.

4.5.2 shall: This word is understood to be mandatory.

4.5.3 should: This word is understood to be advisory.

4.6 label: (See safety sign.)

4.7 panel: Area of the safety sign having a distinctive background color different from adjacent areas of the sign, or which is clearly delineated by a line, border, or margin. There may be up to three (3) panels per sign: signal word, message, and symbol.

4.7.1 signal word panel: Area of the safety sign that contains the signal word. For personal injury hazards, the signal word panel also contains the safety alert symbol.

4.7.2 message panel: Area of the safety sign that contains the word messages which identify the hazard, indicate how to avoid the hazard, and advise of the probable consequence of not avoiding the hazard.^{1,2}

4.7.3 symbol/pictorial panel: Area of the safety sign that contains the symbol/pictorial.

4.8 pictorial: (See symbol/pictorial.)

4.9 placard: (See safety sign.)

4.10 safety alert symbol: (See Annex A) A symbol which indicates a potential personal injury hazard. It is composed of an equilateral triangle surrounding an exclamation mark. The safety alert symbol should not be used to alert persons to property-damage-only accidents.

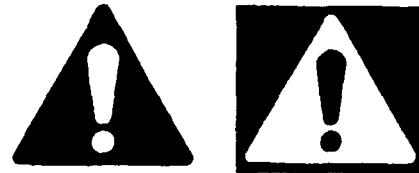


Figure 1 — Safety alert symbol

4.11 safety sign: A visual alerting device in the form of a decal, label, placard, or other marking such as an embossing, stamping, etching, or other process which advises the observer of the nature and degree of the potential hazard(s). It can also describe safety precautions or evasive actions to take, or provide other directions to eliminate or reduce the hazard.

4.11.1 environmental/facility safety sign: Sign or placard in a work or public area that provides safety information about the immediate environment.

4.11.2 product safety sign or label: Sign, label, or decal affixed to a product that provides hazard and safety information about that product.

4.11.2.1 permanent safety sign or label: Information affixed to a product to warn against potential exposure to hazards inherent in the normal use associated with the product, or which might be created during other reasonably anticipated product

¹The order in which the content appears in the message panel is flexible. Factors to consider when determining the order of a word message's content include the target audience's degree of prior knowledge of the hazard and the reaction time required to avoid the hazard.

²When information on consequence, avoidance, or type of hazard is readily inferred, this information may be omitted from the message panel. See Annex B 3.1.

use. The sign or label is to be permanently affixed to the product so that it cannot be easily removed.

4.11.2.2 temporary safety sign or tag:

Information affixed to a product or its container to warn of a temporary hazard created by situations such as shipment, setup, service or repair. Temporary safety signs and tags are removed when the hazard no longer exists.

4.12 sign classifications: Various categories of signs, each with a distinct signal word and colors, which represent different levels of hazards.

4.13 signal word: The word or words that call attention to the safety sign and designate a degree or level of hazard seriousness. The signal words for product safety signs are DANGER, WARNING and CAUTION.

4.13.1 DANGER: Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury. This signal word is to be limited to the most extreme situations.

4.13.2 WARNING: Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

4.13.3 CAUTION: Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices.

Note—DANGER or WARNING should not be considered for property damage accidents unless personal injury risk appropriate to these levels is also involved. CAUTION is permitted for property-damage-only accidents. The safety alert symbol should not be used to alert persons to property-damage-only accidents.

4.14 symbol/pictorial: A graphic representation intended to convey a message without the use of words. It may represent a hazard, a hazardous situation, a precaution to avoid a hazard, a result of not avoiding a hazard, or any combination of these messages. (See ANSI Z535.3-1998, *Criteria for Safety Symbols*).

5 Sign classifications

5.1 Hazard classification

Product safety signs and labels are classified according to the relative seriousness of the hazard situation. The determination is based on an estimation of the likelihood of exposure to the hazardous situation and what could happen as a result of exposure to the hazard. For products, there are three hazard classifications which are denoted by the signal words DANGER, WARNING or CAUTION.

5.2 Signal word selection

When no federal, state, or local government code, regulation, standard, or guideline specifies a particular signal word, selection of the signal word should be made in accordance with the definitions provided in Section 4.

5.3 Multiple hazard identification

5.3.1 One sign or label

When more than one hazard situation exists on a product, either in close proximity to each other, or which might be preventable from a common location, it is permissible to use only one safety sign or label provided that the information effectively addresses each hazard.

5.3.2 Levels of seriousness

When multiple hazard situations are addressed on one sign or label, and the hazards are classified at different levels of seriousness, the signal word corresponding to the greatest hazard level shall be used.

6 Sign or label format

6.1 Panels

A product safety sign or label consists of a signal word panel plus a message panel. A symbol/pictorial panel may be used to communicate parts, or all, of the elements of a message panel (see 4.7.2 message panel).

6.2 Panel arrangement

The sign or label panels can be either in a horizontal or vertical arrangement (see Figures 1 through 5). The figures, as shown, are sample formats. Actual size, layout, and proportion may vary depending on application requirements.

6.3 Safety alert symbol

A safety alert symbol, when used with the signal word, shall precede the signal word. The base of the safety alert symbol shall be on the same horizontal line as the base of the letters of the signal word. The height of the safety alert symbol shall equal or exceed the signal word letter height.

6.4 Border

A safety sign or label shall be distinctive on the product. A contrasting border may be used on the sign to achieve distinctiveness.

6.5 Word message

The word message should be concise and readily understood.

6.5.1 Multiple messages should be provided with sufficient space between them, when feasible, to prevent them from visually blending together.

6.5.2 When detailed instructions, precautions, or consequences require lengthy verbiage it shall be permissible to refer the user to the proper instruction manual.

6.6 Pictorial

The pictorial should be readily understood and should effectively communicate the message.

7 Safety sign and label colors

7.1 Standard colors

Safety colors shall conform to ANSI Z535.1-1998, Safety Color Code.

7.2 Signal word panels

7.2.1 DANGER The word DANGER shall be in white letters on a safety red background.

7.2.2 WARNING The word WARNING shall be in black letters on a safety orange background.

7.2.3 CAUTION The word CAUTION shall be in black letters on a safety yellow background.

7.2.4 Safety alert symbol The solid triangle portion shall be the same color as the signal word lettering, and the exclamation mark portion shall be the same color as the signal word panel background.

7.3 Message panel

The message panel should have either black lettering on a white background or white lettering on a black background.

7.4 Symbol/pictorial panel

The symbol/pictorial panel should normally have a black pictorial on a white background. Other colors may be used for pictorial emphasis, such as safety red for fire, etc.

7.5 Border

The border should normally be white. If necessary to achieve better contrast, the border may be black.

7.6 Color options

7.6.1 Other standards. Other colors may be used for compliance with other standards (see 3.2 Exceptions).

7.6.2 Message and symbol/pictorial panels. When special circumstances limit the use of sign colors to two colors, the colors assigned to the signal word panel may also be used for the message and symbol/pictorial panels provided that the panel colors contrast with the background color of the product.

7.6.3 Exceptions. When special circumstances preclude the use of safety colors on base materials such as wood, cardboard, metal, plastic, etc., the marking used should (when feasible) contrast with the background color of the base material.

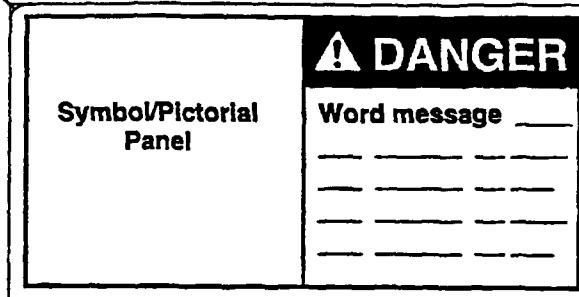
8 Letter style and size

Note—For additional reference on letter style and size, see Annex B.

DANGER

Corners may be radiused.

Signal Word: White Lettering/Red Background
Safety Alert Symbol: White Triangle/Red Exclamation Point



Symbol/Pictorial:
Black Symbol/Pictorial on White Background

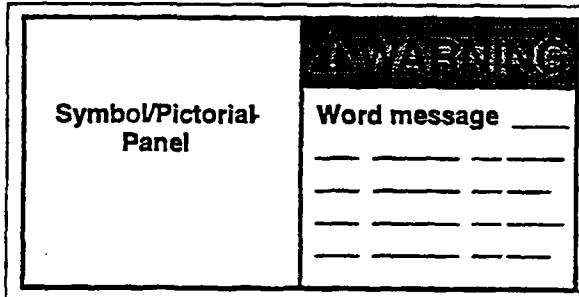
Word Message:
Black Lettering on White Background
(or)
White Lettering on Black Background

Border: White

Color Options:
See 3.2, 7.6.1,
7.6.2, 7.6.3

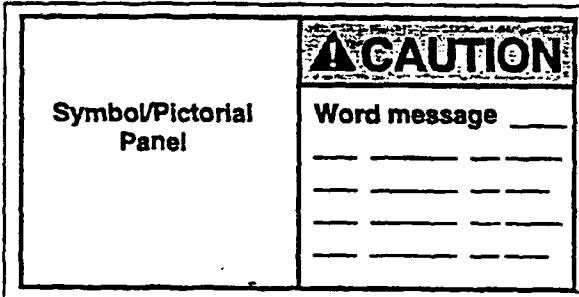
WARNING

Signal Word: Black Lettering/Orange Background
Safety Alert Symbol: Black Triangle/Orange Exclamation Point



CAUTION

Signal Word: Black Lettering/Yellow Background
Safety Alert Symbol: Black Triangle/Yellow Exclamation Point



Format can be extended to provide additional space for the word message.

Figure 2 — Three-panel sign – horizontal format

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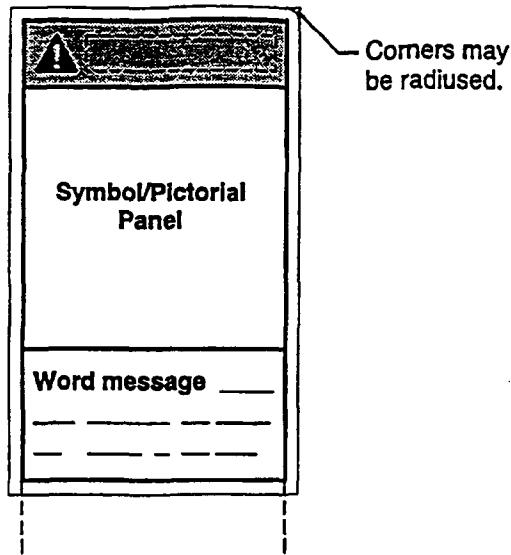


Figure 3 — Three-panel sign – vertical format

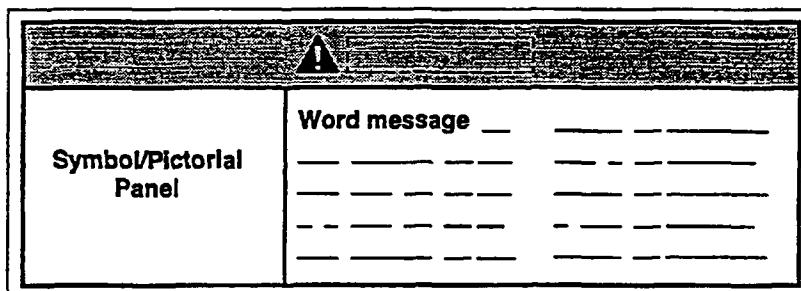


Figure 4 — Three-panel sign – horizontal format

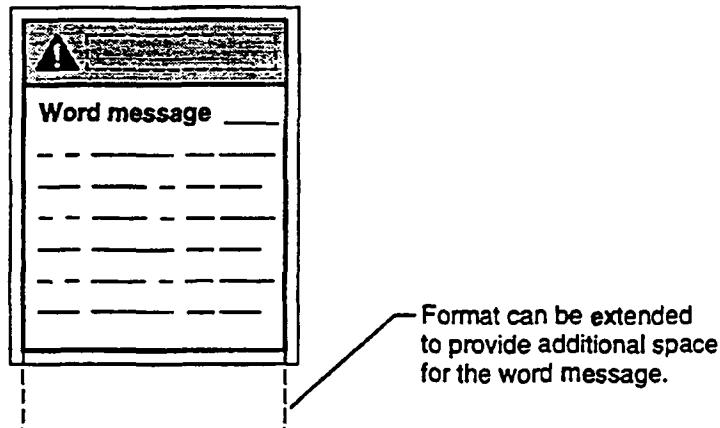


Figure 5 — Two-panel sign – vertical format

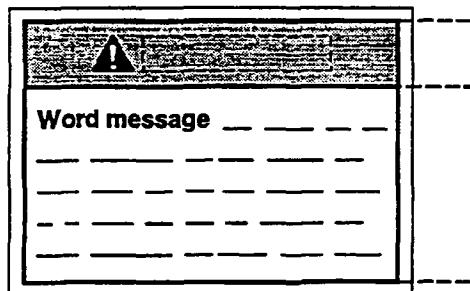


Figure 6 — Two-panel sign – horizontal format

- ANSI Z535.4-1998

11 Symbols/pictorials

11.1 General

11.1.1 Symbols and pictorials are graphic representations chosen to clearly convey a specific alerting message.

11.1.2 The conveyed message of a symbol/pictorial is to describe the type of hazard, potential consequences of the hazard, or evasive/avoidance actions to be taken. When used, the symbol/pictorial must be compatible with the word message(s).

11.2 Symbol/pictorial use

Symbols and pictorials may be used to clarify, supplement or substitute for a portion of the word message found in the message panel of product safety signs. Only symbols validated for recognition should be used. Symbols/pictorials that have not been validated for recognition may only be used to supplement or clarify the word message on the product safety sign.

12 References

12.1 General

This standard shall be used in conjunction with American National Standards listed in 12.2. Other standards listed in 12.3 and other publications listed in 12.4 contain additional information that may be useful in completing the requirements of this standard.

12.2 American National Standards

When the following American National Standards are superseded by a revision approved by the American National Standards Institute, Inc., the revision shall apply.

1. American National Standards Institute (ANSI). *Safety Color Code*, ANSI Z535.1-1998.

2. American National Standards Institute (ANSI). *Environmental and Facility Safety Signs*, ANSI Z535.2-1998.

3. American National Standards Institute (ANSI). *Criteria for Safety Symbols/Pictorials*, ANSI Z535.3-1998.

4. American National Standards Institute (ANSI). *Accident Prevention Tags for Temporary Hazards*, ANSI Z535.5-1998.

12.3 Other standards

1. American National Standards Institute (ANSI). *Precautionary Labeling of Hazardous Industrial Chemicals*. New York: ANSI Z129.1-1994.

2. American Society for Testing and Materials (ASTM). *Standard Practice for Operating Light-Exposure Apparatus (Carbon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials*. ASTM Section 14, Volume 14.02, Designation G23-95. Philadelphia, PA: 1997 Annual Book of ASTM Standards.

3. American Society for Testing and Materials (ASTM). *Practice for Operating Light-Exposure Apparatus (Xenon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials*. ASTM Section 14, Volume 14.02, Designation G26-95. Philadelphia, PA: 1997 Annual Book of ASTM Standards.

4. Underwriters Laboratories, Inc. (UL). *Standard for Marking and Labeling Systems*. Northbrook IL: UL969-1989.

12.4 Other publications

1. FMC Corporation, *Product Safety Sign and Label System*, FMC: Santa Clara, CA. 1985.

2. Smith, Sidney L., *Letter Size and Legibility, Human Factors*, 1979, 21 (60, 661-670).

3. Howett, Gerald L., *Size of Letters Required for Visibility as a Function of Viewing Distance and Observer Visual Acuity*, National Bureau of Standards, 1983.

4. Westinghouse Electric Corporation, *Westinghouse Product Safety Label Handbook*, Westinghouse: Trafford, PA. 1981

8.1 Letter style

8.1.1 Signal words shall be in sans serif letters in upper case only.

8.1.2 Message panel lettering should be a combination of upper and lower case sans serif letters. Serif lettering may be used for longer text. Upper case only lettering may be used for short messages or emphasis of individual words.

8.1.3 Examples of acceptable lettering styles include: Arial, Arial Bold, Folio Medium, Franklin Gothic, Helvetica, Helvetica Bold, Meta Bold, News Gothic Bold, Poster Gothic, and Univers.

8.2 Letter size

8.2.1 Lettering shall be of a size that enables a person with normal vision, including corrected vision, to read the safety sign or label at a safe viewing distance from the hazard.

8.2.2 Safe viewing distance for the signal word shall take into consideration a reasonable hazard avoidance reaction time.

8.2.3 Safe viewing distance for the message panel wording may be different from the safe viewing distance for the signal word.

8.2.4 Signal word letter height should be at least 50 percent greater than the selected height of the majority of the message panel wording.

9 Sign and label placement

9.1 Location

Product safety signs and labels shall be placed such that they will: (1) be readily visible to the intended viewer and (2) alert the viewer to the potential hazard in time to take appropriate action.

9.2 Protection

When feasible, placement of the sign or label should provide protection from foreseeable damage, fading, or visual obstruction caused by abrasion, ultraviolet light, or substances such as lubricants, chemicals and dirt.

10 Expected life and maintenance

10.1 Expected life

Product safety signs or labels shall have a reasonable expected life with good color stability, pictorial legibility, and word message legibility when viewed at a safe viewing distance as described in Section 8.2. Reasonable expected life shall take into consideration the expected life of the product and the foreseeable environment of use.

Note—While there is no definition provided for "legibility" and "safe viewing distance," paragraphs 8.2.1 thru 8.2.3, paragraph 9.1 and Annex B do provide some guidance for interpretation.

10.2 Product user instructions

The manufacturer should include information on maintenance or replacement of safety signs or labels as detailed in 10.2.1 through 10.2.3. If accompanying collateral material is provided, this information may be included.

10.2.1 Maintenance

Product safety signs or labels should be periodically inspected and cleaned by the product user as necessary to maintain good legibility for safe viewing distance as described in Section 8.2.

10.2.2 Replacement

Product safety signs or labels should be replaced by the product user when they no longer meet the legibility requirements for safe viewing distance as described in Section 8.2. In cases where products have an extensive expected life or where exposed to extreme conditions, the product user should contact either the product manufacturer or some other source to determine a means for obtaining replacement signs or labels.

10.2.3 Installation procedure

Installation of new or replacement safety signs or labels should be in accordance with the sign or label manufacturer's recommended procedure.

Annex A

(Informative)

Guidelines for increasing recognition of safety label components**A1 Scope**

It is important that the meaning of a product safety label is clearly understood by those who use or service the product. To increase the understanding of a safety label's components, the ANSI Z535 committee strongly encourages product manufacturers to incorporate the following information in their products' collateral material (e.g., operation manuals, instructions, safety literature, service manuals, etc.). Doing so will assist in the objective of achieving a national uniform system for the recognition of potential personal injury hazards. In addition, reproducing your products' safety labels in accompanying collateral material is recommended.

A1.2 The signal words**A1.1 The safety alert symbol**

Explain the meaning of the safety alert symbol. Then use this symbol whenever a safety-related message is written that warns of a potential personal injury hazard. In literature that makes note of potential personal injury hazards, the safety alert symbol can be used alone or in combination with the proper signal word to call attention to the hazard information. The following artwork may be used for this purpose.



This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

Explain the meaning of the different signal words as defined by the ANSI Z535.4 standard. Such training is necessary to increase understanding of the multi-tier hazard classification system. The following artwork may be used for this purpose. (Note: The use of the appropriate color for each signal word panel is desirable. See the ANSI Z535 color chart at the front of this standard).



DANGER indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.



WARNING indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.



CAUTION indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.



CAUTION used without the safety alert symbol indicates a potentially hazardous situation which, if not avoided, may result in property damage.

A1.3 The symbols/pictorials

Explain the meaning of the symbols and pictorials used on your safety labels. This enables the viewer to better understand the meaning of the graphics and makes future recognition of the symbols/pictorials more instantaneous. Additional information may be added in your literature to further explain the meaning of each symbol/pictorial. See ANSI Z535.3 *Criteria for Safety Symbols* for more information about symbol/pictorial selection, design and testing.

Annex B

(Informative)

Principles and guidelines for the design of product safety signs and labels**B1 Scope**

Good consistent visual design helps to effectively communicate hazard information. The purpose of this annex provides the designer with information on widely recognized principles that can aid in the development of effective product safety signs.^{1,2}

B2 Signal word panel arrangement

The safety alert symbol and signal word should be positioned close together and centered in the signal word panel. Note that the signal word should always be typeset using all capital letters. For property-damage-only safety signs, the signal word CAUTION is used without the safety alert symbol (see Annex A).



Figure 1 — Examples of Correct Safety Alert Symbol and Signal Word Placement



Figure 2 — Examples of Incorrect Safety Alert Symbol and Signal Word Placement

B3 Developing the word message**B3.1 The content of the word message**

The word message on a product safety sign typically communicates information to an observer on the type of hazard, the consequence of not avoiding the hazard and how to avoid the hazard. Many factors must be considered when determining whether to omit consequence, avoidance or type of hazard information in the word message. Factors to consider include whether the message can be inferred from a symbol/pictorial, other text messages, user training or the context in which the safety sign is used.

B3.2 Ordering the content of the word message

The order in which the content appears in the message panel is flexible. Factors to consider when determining the order of a word message's content include the target audience's degree of prior knowledge of the hazard and the reaction time required to avoid the hazard.

Figure 3 illustrates a word message that explains the type of hazard and consequences of interaction with the hazard before it describes the hazard avoidance information. Placing the information in this order would be appropriate if it is found that the audience needs to know what the hazard is before they would follow the avoidance information presented on the label. This format assumes that there is time to read the entire word message and still avoid the hazard.

Moving parts can
crush and cut.
Keep hands clear
while operating.
Lockout power
before servicing.

Figure 3

¹ In this Annex, the term "sign" will be used to mean either a product safety sign or label.

² Note—Every safety sign must be considered on its own terms. Limitations on space or other unique conditions may justify variance from these principles. Examples of word messages are provided to illustrate how principles related to grammatical structure, writing style and print layout can enhance the safety sign. These examples are not intended to prescribe standardized word messages for the hazards mentioned in the examples.

Figure 4 illustrates a word message that places the hazard avoidance information first. Ordering the word message in this way would be appropriate if a person needs to immediately follow the avoidance information in order to prevent interaction with the hazard.

Keep out.
Hazardous
voltage inside.
440 Volts.

Figure 4

B3.2 Formatting the word message

There are many issues that must be considered when developing a word message; from sentence structure to typesetting specifications. The length of the word message depends on the amount of information that needs to be communicated to a person to allow them to understand and avoid the hazard. Once this information is determined, it should be written and formatted in a manner that is concise and easily understood. The following are several principles that can be applied to the word message to achieve this objective.

B3.2.1 Use headline style

Write in a "headline style." Compare the sample word messages shown below. The "headline style" example eliminates nonessential words and omits pronouns ("this," "that," "they,") articles ("a," "the," "an") and forms of the verb "to be" ("is," "are," "were"). Avoid hyphenation when at all possible.

Headline Style Message

Moving parts can
crush and cut.
Keep guard in place.
Lock out power
before servicing.

Non-Headline Style Message

This machine has moving parts
that can crush and cut. Keep the
guard in place while operating this
machine. Before servicing is
performed, lock out the power.

B3.2.2 Use active voice

Write sentences in the active voice, rather than the passive voice. This means placing the subject of the sentence first, the action (verb) next, and the object (noun) last. Often the subject "you" or "your" can be inferred from the sentence and is unnecessary.

Active Voice Sentences

Keep hands away from rotating
blade.

Lock out power before servicing
equipment.

Immediately replace guards after
repair or adjustment.

Passive Voice Sentences

Your hands must be kept away
from rotating blade.

Power must be locked out before
servicing equipment.

After repair or adjustment,
immediately replace guards.

B3.2.3. Avoid prepositional phrases

Avoid the use of prepositional phrases. Prepositional phrases can often be eliminated or replaced with one word.

Sentences Without Prepositional Phrases

Disconnect power to service
equipment.

Turn off power if jam occurs.

Sentences With Prepositional Phrases

Disconnect power in order to
service equipment.

Turn off power in the event a jam
occurs.

B3.2.4 Refer to another source

Keep only essential hazard-related information in the product safety sign. If necessary, consideration can be given to referring the viewer to another source for additional safety information. Examples of such sources include safety instruction labels, operation manuals, service manuals, operating procedures and safety bulletins.

B3.2.5 Separation of word message content

To enhance readability, the word message may be arranged in an outline format. The addition of bullets may also be considered to help separate portions of the word message.

Outline Format

**Moving parts can
crush and cut.**
**Keep hands clear
while operating.**
**Lockout power
before servicing.**

Outline With Bullet Format

**Moving parts can
crush and cut.**
• **Keep hands clear
while operating.**
• **Lockout power
before servicing.**

Continuous Format

**Moving parts can crush and
cut. Keep hands clear
while operating. Lockout
power before servicing.**

B3.2.6 Text justification

Left aligned "ragged right" text should be used for all but one-line text messages (which can be either left aligned or centered). Left alignment aids in readability by creating a vertical line that the eye naturally locates when searching for the next line of text. Justified text should be avoided because the added space between words makes it more difficult to read.

Left Aligned Ragged Right Text

**Moving parts can
crush and cut.**
**Keep hands clear
while operating.**
**Lockout power
before servicing.**

Centered Text

**Moving parts can crush
and cut.**
**Keep hands clear while
operating.**
**Lockout power before
servicing.**

Justified Text

**Moving parts can
crush and cut.**
**Keep hands clear
while operating.**
**Lockout power
before servicing.**

B3.2.7 Upper and lower case letters

The preferred format for text is the use of mixed upper and lower case where only the first letter of the first word in a sentence is capitalized. The use of all upper case letters for the word message is discouraged because it is more difficult to read quickly than lower case type. On occasion, a single word or phrase may be set in upper case letters to provide emphasis.

Mixed Case Lettering

**Moving parts can
crush and cut.**
**Do not remove
guard.**
**Lockout power
before servicing.**

Selective Use of Upper Case

**Moving parts can
crush and cut.**
**Do NOT remove
guard.**
**LOCKOUT power
before servicing.**

All Upper Case

**MOVING PARTS CAN
CRUSH AND CUT.**
**DO NOT REMOVE
GUARD.**
**LOCKOUT POWER
BEFORE SERVICING.**

B3.2.8 Choice of type style

Sans serif typestyles are preferred for short word messages. Serif typestyles may be used but should be limited to safety labels which contain large amounts of text. The important specification to look for when choosing a typestyle is the stroke "width-to-height" ratio. This ratio refers to the width of the letter and the strokes used to create the letter and should be between 1:6 – 1:8 (see reference 3).

Arial/Helvetica	Futura
Arial/Helvetica Bold	News Gothic Bold
Folio Medium	Meta Bold
Franklin Gothic	Univers

Figure 5 — Examples of Sans Serif Typestyles

B3.2.9 Choice of type spacing

The correct spacing between lines of text, between words, and between letters helps to make a word message easier to read. The amount of space between lines of text is called leading. Lines of text should be separated by leading that is approximately 120% of the type point size (e.g., 10 point type should have 12 point leading, 14 point type should have 16.8 point leading, etc.). Additional leading can be added to separate portions of a word message, as shown in the outline format illustrated in A4.2.5. The space between words and between letters is called tracking. For purposes of legibility, it is important to use proper word and letter spacing when typesetting the word message.

This is an example of a word message with proper leading and word/letter spacing.

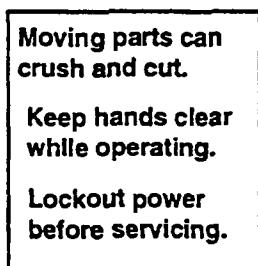
This is an example of a word message with too much leading and too much word/letter spacing.

This is an example of a word message with not enough leading and not enough word/letter spacing.

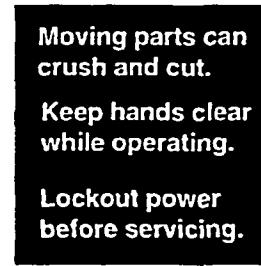
Figure 6 — Examples of Correct and Incorrect Type Spacing

B3.2.10 Choice of type color

The word message's type can be black on a white background or white on a black background. This choice should be based on which is more legible. But legibility is dependent on more than type color. Factors such as type size, amount of text, reading distance, contrast with the product surface, and lighting conditions must all be considered.



Black type on a white background



White type on a black background

Figure 7 — Examples of Type Color Choice

B3.2.11 Comprehension

The word message should be written so that it can be understood by the target audience (i.e., those who are to use and/or service the product). This means choosing words that accurately describe the specific hazard and avoidance information in terms the intended audience will understand.

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B3.2.12 Letter size

Legibility of the word message at the minimum safe viewing distance³ determines the proper letter size for the word message. The letter size/safe viewing distance guidelines in Table 1 define the type size required to achieve legibility at the given viewing distance. The height of the capital letter "H" is used to determine the proper measurement. Note that the type sizes shown indicate the minimum or recommended word message letter size. A word message's type size may need to be larger in order to obtain conspicuity from other information presented on the product. A larger type size may also be desired in order to warn persons at distances greater than the minimum safe viewing distance. Portions of a word message may appear in a larger type size for special emphasis. Final determination of letter height should be based on a visual examination of the formatted word message in light conditions similar to the reasonably expected environment of use. It is advisable to test different type size versions of the safety label to determine the optimum size for readability at the desired viewing distance. The designer should also consider the age-level of the intended audience when testing the word message for legibility.

B3.2.13 Minimum letter height calculations

Type size is defined in "points," a term that was used to describe the space required for lead type characters. Point sizes measure from the top of the capital letters to the bottom of the lower case letters with descenders (e.g. the bottom of the letter "g" or "j" etc.). One point equals 0.01384 inches, or approximately 1/72 of an inch. Although type faces vary slightly, a practical guide for defining type size is based on using the capital letter "H" for measurement purposes. Since the character "H" has no descender, it is possible to use a conversion factor of 0.01 inches = 1 point of type size. Thus, 12 point type yields a capital "H" approximately 0.12 inches high. For metric purposes, use a conversion factor of 3.9 points = 1 mm of height for a capital "H."

Recommended Letter Heights For Favorable Reading Conditions:

2 Feet Or Less: Viewing Distance (in.) / 150

>2 To 20 Feet: Viewing Distance ((ft. - 2) x (.03)) + .16

Over 20 Feet: Viewing Distance (ft.)/ 28.6

Recommended Letter Heights For Unfavorable Reading Conditions (All Distances):

Viewing Distance (ft.) x .084

Table — Examples of word message letter heights and minimum safe viewing distances

Minimum Safe Viewing Distance ³	Minimum Letter Height For FAVORABLE Reading Conditions	Recommended Letter Height For FAVORABLE Reading Conditions	Recommended Letter Height For UNFAVORABLE Reading Conditions
1 Foot or less*	.08 Inches	.08 Inches	.084 Inches
2 Feet	.10 Inches	.16 Inches	.168 Inches
3 Feet	.12 Inches	.19 Inches	.252 Inches
4 Feet	.14 Inches	.22 Inches	.336 Inches
5 Feet	.16 Inches	.25 Inches	.420 Inches
6 Feet	.18 Inches	.28 Inches	.504 Inches
7 Feet	.20 Inches	.31 Inches	.588 Inches
8 Feet	.22 Inches	.34 Inches	.672 Inches

*.08 inch type is the suggested minimum type size for use on product safety signs.

B4 The use of symbols/pictorials

Well designed symbols and pictorials can often communicate hazard information quickly and across language barriers. Although the ANSI Z535.4 standard allows word-message-only formats for safety labels, the use of symbols and pictorials is encouraged whenever practical. See ANSI Z535.3 *Criteria For Safety Symbols* for additional information concerning symbol/pictorial selection, design and testing.

B5 Multi-lingual formats

The selection of additional languages for product safety signs is an extremely complex issue. Experts suggest that nearly 150 foreign languages are spoken in the United States and over 23 million Americans speak

³The minimum safe viewing distance refers to the closest distance a person can be to the label and still have time to follow the safety sign's message to avoid the hazard.

a language other than English in their homes. If it is determined that additional languages are desired on a safety sign, the following formats may be considered. In all examples, the use of symbols/pictorials is strongly encouraged in order to better communicate the sign's hazard information across language barriers. White type on a black background is used in these examples to highlight the symbol/pictorial and word message panels.

B5.1 Vertical formats

The vertical bilingual format shown in Figure 8 can be modified to include a longer word message by lengthening the word message panels.

B5.2 Horizontal Formats

Figures 9 and 10 illustrate horizontal formats for bilingual safety labels. In Figure 9, the English word message and signal word may appear on either the right or left side. The text and signal word panels may be widened to accommodate longer word messages.

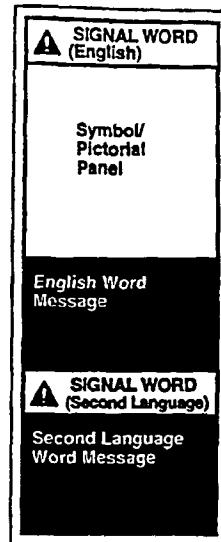


Figure 8

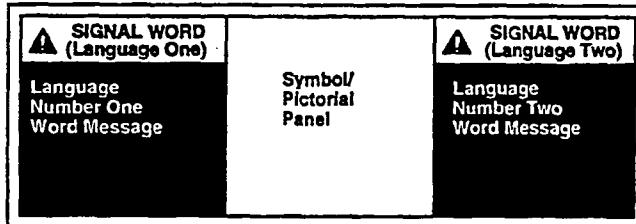


Figure 9

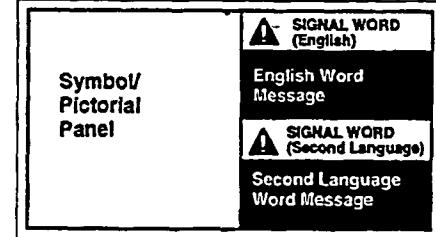


Figure 10

B5.3 Signal Word Panel Arrangement

The safety alert symbol and signal word should be positioned close together and centered in each signal word panel of a bilingual safety sign (see B2).

B5.4 Letter Size

A slightly smaller type size may be needed to accommodate the length of a translated signal word or word message.

B6 Multi-Hazard Formats

If multiple hazards exist at one location or if there is only enough space for a single safety label, a multi-hazard label may need to be considered. The use of symbols/pictorials in multi-hazard formats is optional but encouraged. Additional symbols/pictorials can be added to these formats as needed. The signal word corresponding to the hazard with the greatest seriousness level should be used (see ANSI Z535.4, section 5.3.2). The hazard with the greatest seriousness level should be ordered first in the word message. White type on a black background is used in these examples to highlight the pictorial and word message panels. The following options can be considered when designing multi-hazard signs.

B6.1 Three-panel Formats

Use one of the standard three-panel formats shown in Figures 1, 2 and 3 of the ANSI Z535.4 standard and use a single symbol/pictorial to communicate the most important hazard. Use the outline format to separate the various hazard word messages (see B3.2.5).

B6.2 Two-panel Formats

Use the two-panel signal word/word message formats shown in Figures 4 and 5 of the ANSI Z535.4 standard. Use the outline format to separate the various hazard word messages (see B3.2.5).

B6.3 Multi-pictorial Formats

Use one of the multi-symbol/pictorial formats shown in Figures 11 through 13. In formats 11 and 12, place the most important hazard symbol/pictorial in the upper left panel so that it is "read" first and order the word message segments so they correspond to the order of the symbol/pictorials ("reading" the symbols/pictorials from left to right or top to bottom). If the format shown in Figure 12 is used, arrange the word message segments so they line up opposite the appropriate symbol/pictorial panel.

